FEDERAL AID IN SPORT FISH RESTORATION
Volume 3, Number 5A

Broodstock Development Center
Section A: Annual Report

by
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F-27-R

Alaska Department of Fish and Game
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October 1988

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RESEARCH PROJECT SEGMENT

State: Alaska

Name: Southcentral Sport Fisheries Enhancement

Project: F-27-R

Study Title: Broodstock Development Center
Section A: Annual Report

Cooperator: Irvin Brock

Period Covered: 1 July 1987 to 30 June 1988

ABSTRACT

Rainbow trout, *Salmo gairdneri*, broodstock from the Swanson River, Big Lake, and Swanson River select strains have been maintained at the Broodstock Development Center (BDC). In the spring of 1988, approximately 6.1 million eggs were taken at the BDC for the rainbow trout production program. For the broodstock selection project, performance indices were calculated to make a selection of 16 families of rainbow trout out of a total of 64 families (brood year [BY] 1987) and the selection of 32 families out of 64 families (BY 1988) was made. A final selection of 16 families (BY 1988) will occur during fiscal year (FY) 1989.

The following research projects are being conducted by the BDC: (1) oxygen generation, (2) rearing models, (3) female age vs. egg quality, (4) rainbow trout egg survival: a male or female trait, (5) rainbow trout egg fertilization, (6) rainbow trout diet comparison (production), (7) rainbow trout diet comparison (broodstock), (8) rainbow trout broodstock questionnaire, (9) production of all-female broodstock, and (10) production of triploid rainbow trout. Unfortunately, not all are funded and not all are being implemented.

KEY WORDS: Fort Richardson Hatchery, Broodstock Development Center, rainbow trout, *Salmo gairdneri*, broodstock

selection, genetics, broodstock maintenance, fish culture research.

INTRODUCTION

The rainbow trout, *Salmo gairdneri*, production program at Fort Richardson Hatchery supports the rainbow trout sport fishery enhancement programs in southcentral and interior Alaska. Maintenance of these programs requires a reliable source of viable eggs. Fry produced from these eggs must be able to survive in both hatchery and wild environments. To date, however, "performance" of the existing strains of rainbow trout in the hatchery has not been good. Wild broodstocks have been used, but generally these have notoriously poor survival in a hatchery system. Therefore, the goal of this program is to develop a hatchery strain of broodstock that exhibits an improved in-hatchery performance while retaining desirable "wild" characteristics. In addition, the BDC was also designed as a small research facility to solve other problems encountered in the production of rainbow trout and other species.

To accomplish these goals, the BDC was established as a part of the Fort Richardson Hatchery. The physical structures include the BDC building and nine outdoor raceways (3.1 x 30.5 x 0.9 m) that are located adjacent to a spawning shed that is attached to the BDC building. The BDC building houses a "wet laboratory" for incubation and rearing and a "dry laboratory" for water-quality analyses and basic fish health inspections. The water supply and other support facilities are provided by the Fort Richardson Hatchery.

Presently, two rainbow trout broodstocks are maintained: Swanson River and Big Lake. Random matings within these stocks produce all the eggs for southcentral and interior Alaska rainbow trout

sport fishery enhancement programs. A genetic selection project was begun two years ago to develop a new strain of rainbow trout that spawns earlier, grows faster, and has higher survival rates. This program is based on individual and family selection within the Swanson River broodstock, and its design is similar to the program developed by Graham Gall (1972) for the State of California. Obviously, this is a long-term program, because the speed of genetic selection is a function of generation time.

Research projects studied by BDC staff during the past year included: (1) oxygen generation, (2) rearing models, (3) female age vs. egg quality, (4) rainbow trout egg survival as it relates to parental traits, (5) rainbow trout egg fertilization, (6) a rainbow trout production-lot feed comparison, (7) a rainbow trout broodstock feed comparison, (8) a rainbow trout broodstock questionnaire, (9) production of all-female rainbow trout, and (10) experimental production of triploid rainbow trout.

OBJECTIVES

The following are primary objectives:

1. Maintain rainbow trout broodstock to supply eggs for the stocking requirements of the enhancement program (Broodstock Maintenance Project).

2. Collect adequate numbers of rainbow trout eggs annually to supply (a) the rainbow trout enhancement program, (b) broodstock replacement, and (c) the broodstock selection project (Random-Lot Spawning Project).

3. Develop a strain of rainbow trout that survives and grows well in the hatchery and in the waters where they are planted (Broodstock Selection Project).

The secondary objective is to propose and implement projects designed to make production of rainbow trout and other species more efficient (Production Improvement Projects).

PROJECT PERFORMANCE AND EVALUATION

Federal Aid annual reports include detailed summaries of the three primary projects (Broodstock Maintenance, Random-Lot Spawning, and Broodstock Selection). Production Improvement Projects are summarized and reported as soon as they are completed. These final reports will be attached to the appropriate Federal Aid reports (annual or quarterly). Brief descriptive updates, however, are included in this annual report.

The reporting period for this paper is 1 July 1987 through 30 June 1988. However, the Broodstock Selection Project is reported on a brood-year basis for better continuity and to reduce confusion. Technical reports for secondary projects will be submitted upon completion.

Broodstock Maintenance Project

General Information:

The goal of this project is to maintain enough broodstock from both the Big Lake and Swanson River strains to meet the requirements of rainbow trout sport fishery enhancement programs for southcentral and interior Alaska.

Methods and Materials:

Because the water supply is limited, a "three-pass" water-reuse system is used for the broodstock raceways. Mature fish from the Swanson River broodstock are held in first-pass water so they can

move up the fish ladder into the spawning shed as they become ripe. Broodstock from the Big Lake strain and the Swanson River select strain are held in second-pass water, and replacement lots of broodstock are held in third-pass water. Replacement lots for both Big Lake and Swanson River strains are held in the Fort Richardson Hatchery until transferred into the broodstock raceways at 8 to 9 months of age. Fish from the replacement lots "replace" spawners in the Big Lake or Swanson River lots that either die during rearing or are discarded after spawning as 4-year-olds.

Results and Discussion:

Rainbow trout broodstock on hand at the BDC on 1 July 1987 included eight lots of fish from five brood years and two wild stocks (Table 1). These lots of fish were kept in the BDC's broodstock raceways and indoor rearing tanks throughout the year. At the end of FY 1988, individuals in each lot were enumerated and moved to their present raceways. Two lots of replacement broodstock (BY-1987 Swanson River and BY-1987 Big Lake random lots) were transferred from production raceways to broodstock raceways in January of 1988. BY-1987 select-lot families were moved to an outside broodstock raceway in May 1988. Table 2 summarizes the rainbow trout broodstock on hand at the BDC on 30 June 1988, and Table 3 forecasts the numbers of broodstock and eggs that will potentially be available between 1989 and 1991 to accommodate the Alaska Department of Fish and Game (ADF&G), Sport Fish Division stocking program. Each year the planning assumptions and the broodstock and egg numbers will be updated.

Water temperature was maintained at the same temperature in each of the broodstock raceways. The average monthly water temperatures ranged from 3.3°C in January 1988 to 12.1°C in July 1987 (Table 4).

Table 1. Rainbow trout broodstock at Broodstock Development Center, 1 July 1987.

Lot Number	Brood Year	Description of lot	Number of fish
82RTSR	1982	Swanson River (wild)	317
82RTBL	1982	Big Lake (wild)	<20
84RTSR	1984	Swanson River (wild)	876
84RTBL	1984	Big Lake (wild)	<50
85RTSR	1985	Swanson River (random lot)	1724
85RTBL	1985	Big Lake (random lot)	5101
86RTSR(S)	1986	Swanson River (select lot)	5640
87RTSR(S)	1987	Swanson River (select lot)	28853

Table 2. Rainbow trout broodstock at Broodstock Development Center, 30 June 1988.

Lot number	Brood Year	Description of lot	Number of fish
82RTSR	1982	Swanson River (wild)	
84RTSR	1984	Swanson River (wild)	
85RTSR	1985	Swanson River (random lot)	
		Total (combined in one raceway)	1321
84RTBL	1984	Big Lake (wild)	
85RTBL	1985	Big Lake (random lot)	
		Total (combined in one raceway)	1496
86RTSR(S)	1986	Swanson River (select lot)	3200
87RTSR	1987	Swanson River (random lot)	6414
87RTBL	1987	Big Lake (random lot)	4093
87RTSR(S)	1987	Swanson River (select lot)	3182
88RTSR(S)	1988	Swanson River (select lot)	57093

Table 3. Forecasted numbers of rainbow trout broodstock and potential numbers of eggs at the Broodstock Development Center, 1989-1991.

Lot number	Broodstock origin	Brood year 1989 Number Broodstock	1989 Number Potential eggs	1990 Number Broodstock	1990 Number Potential eggs	1991 Number Broodstock	1991 Number Potential eggs
82RTSR	Swanson River	200	360,000	0	0	0	0
84RTSR	Swanson River	250	450,000	0	0	0	0
85RTSR	Swanson River	800	1,080,000	0	0	0	0
85RTBL	Big Lake	1500	1,687,500	0	0	0	0
86RTSR(S)	Swanson River (select)	3100	3,487,500	1550	1,743,000	0	0
87RTSR	Swanson River	~6000	0	3000	3,375,000	1500	2,025,000
87RTBL	Big Lake	~3000	0	1500	1,125,000	750	843,000
87RTSR(S)	Swanson River (select)	~3200	0	1600	1,800,000	800	900,000
88RTSR	Swanson River	~4000	0	~4000	0	2000	2,250,000
88RTBL	Big Lake	~2000	0	~2000	0	1000	750,000
88RTSR(S)	Swanson River (select)	~3200	0	~3200	0	1600	1,800,000
Total	Swanson River		1,890,000		3,375,000		4,275,000
Total	Big Lake		1,687,500		1,125,000		1,593,000
Total	Swanson River(select)		3,487,500		3,543,000		2,700,000
Total	All broodstocks		7,065,000		8,043,000		8,568,000

Assumptions:

1. Earliest female spawning age = 3 yr.
2. Annual mortality rate: Age 1 = 0%; Ages 2 and up = 50%.
3. Percentage of females in population after age 2: Big Lake and Swanson River (select) = 75%
   Swanson River age 3 = 75%
   Swanson River age 4 and up = 90%
4. Fecundity: Swanson River age 3 = 1500
   age 4 = 1500
   age 5+ = 2000

   Big Lake age 3 = 1000
   age 4 = 1500

   Swanson River (select) age 3 = 1500
   age 4 = 1500

Table 4. Average monthly water temperatures in broodstock raceways, Broodstock Development Center.

Year	Month	Water temperature (C)
1987	July	12.1
1987	August	11.6
1987	September	10.8
1987	October	7.6
1987	November	5.8
1987	December	4.4
1988	January	3.3
1988	February	3.9
1988	March	8.8
1988	April	7.4
1988	May	8.7
1988	June	9.2

The photoperiod was maintained as natural as possible; artificial lighting was kept to a minimum. Fish were fed double vitamin-pack Oregon Moist Pellet® (OMP), and were fed only the amount that they would eat. During the spawning season, the broodstock ate little, but food was made available to them. Dead fish were removed, counted, and recorded daily.

Post-spawning mortality was high this year, but within planning assumptions.

Random-Lot Spawning Project

General Information:

The goal of this project is to operate the annual rainbow trout egg take in order to collect enough eggs from the Big Lake and Swanson River broodstocks for southcentral and interior Alaska rainbow trout production programs. The progeny from these broodstocks are the result of random matings within each stock. The only artificial selection in this process is for the earliest spawning time.

Methods and Materials:

Swanson River broodstock are spawned in the spawning shed. Fish either migrate out of the raceways, up the fish ladder, and into the sorting pond in the spawning shed, or they are manually moved with dip nets into the shed. Once in the spawning shed, the fish are netted, sorted, and dry-spawned using the oxygen-injection technique. After they have been spawned, fish are returned to a holding raceway via a polyvinyl-chloride tube. Eggs from 8 to 16 females, depending on fecundity, are pooled and immediately fertilized. The male/female sex ratio is kept at a minimum of 1:4. After milt is added, fresh water is added and gently mixed

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by hand. Gametes and water are then transported immediately to the incubation building. After approximately 5 temperature units (TU) are accumulated (12 hr at 10°C), randomly selected eggs are examined to determine the stage of development to evaluate the fertilization rate.

Big Lake broodstock are spawned in their raceways. Fish are crowded to the upper end and ripe fish are spawned in the lower section of the 10 raceways and released. Spawning techniques are the same as for the Swanson River strain.

Results and Discussion:

Unfortunately, only a small percentage of the fish actually use the fish ladder, making it necessary to move most of them from the broodstock raceways to the spawning shed by dip net. Handling the fish in this manner is not only more stressful for the fish, but also more labor-intensive. A more efficient way of moving these fish will be developed in the future.

Random-lot spawning began on 31 March 1988. Water temperature was maintained below 10°C during the spawning season. Approximately 6.1 million eggs were taken in 12 days of egg takes (Table 5). This number of eggs satisfied the requirements of the ADF&G, Sport Fish Division rainbow trout stocking program.

Females were 3, 4, or 6 years old; most males were 2 or 3 years old, as very few 4- or 6-year-old males had survived. Average fecundity (eggs/female) of 3-year-old Swanson River fish was approximately 1,500 eggs, much higher than the 1,000 eggs observed in previous years. These BY-1985 females are the first generation of fish from eggs taken at the BDC. Perhaps better growing conditions in the hatchery contributed to increased fecundity.

Table 5. Summary of egg takes for BY 1988.

Broodstock	Date	Lot Number	Number of eggs	Percent fertility
Swanson River	8 April	88RTSR01	950,729	90.7
	11 April	88RTSR02	277,092	89.4
	12 April	88RTSR03	705,068	91.5
	13 April	88RTSR04	428,504	91.4
	20 April	88RTSR05	1,226,876	86.0
	27 April	88RTSR06	215,381	75.1
Total for Swanson River			3,803,650	88.4
Big Lake	31 March	88RTBL01	309,537	87.0
	1 April	88RTBL02	424,151	89.2
	7 April	88RTBL03	505,176	92.2
	14 April	88RTBL04	591,495	92.0
	21 April	88RTBL05	322,542	N/A
Total for Big Lake			2,152,901	90.5
Swanson River	4/6	Select88	94,400	N/A
	4/12-14	Triploids	30,000	N/A
	4/13	Gynogens	6,000	N/A
Total for special projects			130,400	N/A
Grand Total			6,086,951	89.1

Fish being held for replacement broodstock lots will remain in the indoor production raceways until they are transferred to broodstock raceways in January 1989.

Broodstock Selection Project

General Information:

The goal of this project is to develop a strain of rainbow trout that has high survival and fast growth in both hatchery and wild environments. Eventually, this strain is expected to be selected as the choice domestic broodstock for rainbow trout hatcheries in southcentral Alaska. This project follows a long-term genetic-selection program based on individual and family selection (Table 6).

Methods and Materials:

Lots of fish produced are referred to as "Select Lots", and replacement broodstock for select lots are chosen according to their "performance index." This value is a summation of weighted scores of traits that may result in better growth and survival during egg take, incubation, and rearing. The first selection takes place prior to initial ponding of unfed fry. At this time, a performance index is calculated from three trait values: (1) fecundity (eggs/kg fish); (2) eyed-egg size (g/100 eggs); and (3) survival rate (%) from the green- to eyed-egg stage. Of 64 original families, only 32 are selected and ponded. After the fish have accumulated approximately 1,300 TUs, the second and final selection is made. Performance index is recalculated with two additional traits: survival (%) and growth rate (mg/TU/day) from initial ponding to 1,300 TUs. Of the 32 remaining families, the 16 families with the highest performance indices are retained for the select-lot program (Wall and Olito 1986; Davis and Brock 1985; Brock 1987).

Table 6. Genetic selection program for annual select-lot broodstock production.

	Spawn				Progeny	
	Males		Females			
Year	Number	Brood year	Number	Brood year	Number of families	Lot designation
1986	64	1984	64	1982	64	1986-S
1987	64	1984	64	1984	64	1987-S
1988	64	1985	64	1985	64	1988-S
1989	64	1986-S	64	1987-S	64	1989-S
1990	64	1987-S	64	1988-S	64	1990-S
1991	64	1988-S	64	1988-S	64	1991-S
1992	64	1989-S	64	1989-S	64	1992-S

Because an earlier spawning time would improve the rainbow trout production programs, the earliest spawning fish are selected. Adults from the Swanson River broodstock (random lot) will be used to supply eggs until the first generation of select-lot broodstock mature; thereafter, only select-lot broodstock will be spawned.

Results and Discussion:

The success of the selection program cannot be determined until the progeny are released and harvested. All survival, growth, and production data collected will be used to compare the performance of fish from select lots (both in the hatchery and the wild) with fish from random lots. The random-lot broodstocks will be maintained until there is satisfaction that we have developed a strain of fish that performs in a superior manner. At that time, the broodstock of choice will be the select-lot strain.

Because reporting periods do not match the time frame of the biological processes that make up the selection program, the complete BY-1987 select-lot project will be reported here. Although the selection project for BY-1988 was started in April 1988, selection is not complete at this writing and will be reported in the 1989 Federal Aid annual report.

On 16 April 1987 the eggs were taken from 64 randomly selected females from the BY-1984 Swanson River broodstock. These eggs were all taken in one day from the first females to ripen. Sperm from 64 males randomly selected from the BY-1984 Swanson River broodstock were used to fertilize the eggs (1:1 ratio). During spawning, the following data were collected from each family pair: (1) weight (g); (2) egg size (eggs/g); and (3) estimated fecundity (eggs/fish).

Fertilized, water-hardened eggs from each spawning pair were placed in one quadrant of a compartmentalized Heath® tray and incubated using standard hatchery techniques. Anti-fungal prophylactic treatments were administered three times each week. After the eyed-egg stage was reached, the eggs were shocked, picked by hand after 24 hr, enumerated, and returned to incubators. During incubation, fecundity, green-egg to eyed-egg survival rate, and eyed-egg to hatching survival rate were calculated.

When the fish emerged, 32 selected families were transferred to individual rearing tanks. Excess fish were transferred to Fort Richardson Hatchery production lots. In the rearing tanks, their growth and survival rates were monitored. A second selection was made after 1,300 TUs had been accumulated. The 16 remaining select-lot families with 400 fish in each family from BY 1987 were reared in the BDC wet lab until May 1988. Two hundred fish from each family were pooled and transferred to an outdoor broodstock raceway where they will remain until they are spawned in 1990 and 1991.

The unselected families and excess fish from selected families were transferred to Fort Richardson Hatchery production lots. This year the fish were not marked because the branding program tested on BY-1986 select-lot families had poor results and a new "visible tag" developed by Northwest Marine Technology, Inc. was not available in time.

A summary of scores for traits used to evaluate select-lot families from BY 1987 is presented in Table 7. The score for each trait varied greatly among the families. Table 8 presents the scores for traits for only the final 16 selected families. A comparison between mean-trait scores in Table 7 and mean-trait scores in Table 8 shows the "potential gain" for each trait in the selected families if these traits are heritable.

Table 7. Summary of scores for traits used to evaluate rainbow trout in the broodstock selection project. First selection (from 64 to 32 families) is based on traits 1-3; final selection (from 32 to 16 families) is based on all traits.

Trait		Scores			
Number	Description	Maximum	Minimum	Mean	Standard Deviation
1	Fecundity (eggs/kg fish)	3878	1057	2040	561
2	Eyed egg size (g/100 eggs)	11.5	7.0	9.3	1.2
3	Egg survival (green to eyed)	98.4%	6.5%	80.8%	17.3%
4	Survival (fry to 1300 TU)	97.3%	35.3%	83.1%	13.8%
5	Growth rate (mg/TU/day)	5.17	1.82	2.64	0.62

Table 8. Summary of scores for traits used to evaluate rainbow trout in the final 16 families in the broodstock selection project.

Trait		Scores			
Number	Description	Maximum	Minimum	Mean	Standard Deviation
1	Fecundity (eggs/kg fish)	2893	1478	2118	383
2	Eyed egg size (g/100 eggs)	11.4	8.2	10.1	1.0
3	Egg survival (green to eyed)	97.3%	61.4%	86.8%	10.2%
4	Survival (fry to 1300 TU)	97.3%	74.1%	90.6%	6.1%
5	Growth rate (mg/TU/day)	5.17	2.27	3.01	0.64

PRODUCTION IMPROVEMENT PROJECTS

The production improvement projects described below are secondary to the primary goals of the BDC, but they fulfill the important function of solving problems that may limit or alter fish production and broodstock maintenance in hatcheries. Work on ten of these projects had been proposed for FY 1988, but some projects were not implemented due to a lack of funding.

Oxygen Generation Project

General Information:

Currently, Fort Richardson Hatchery fish production is being limited by lack of water. The cost of producing more ground water (if it can be found) is quite high, forcing us to seek alternative measures to meet fish-production goals. This project was designed to test the use of pure oxygen to increase the carrying capacity of the water already available for use at the hatchery. For the same amount of production, it may be possible to reduce the required flow by as much as 38% at 10°C. A reduction of this magnitude, while still meeting the metabolic requirements of the fish, could reduce the cost of pumping water significantly and allow the hatchery to operate more efficiently. This technology is being used in State of Michigan and European hatcheries to "strip" nitrogen gas to below saturation values while raising the dissolved-oxygen concentration to above saturation values. This allows higher-than-normal concentrations of fish. The short-range potential use for this technology at Fort Richardson Hatchery will be to increase the dissolved-oxygen concentration and reduce nitrogen gas concentration so that available water can be used more efficiently. Although the project is being performed at Fort Richardson Hatchery, the potential application of this technology at other hatcheries is great.

Project Status:

No work was accomplished on the oxygen-generation project this year. Lack of funding for personnel to conduct the necessary tests and analyze the data has caused this project to become dormant. Nonetheless, assistance and information is provided by the BDC staff to anyone interested in this new technology. Funding for this project will continue to be requested.

Rearing Models

General Information:

Various models have been used to design hatcheries in Alaska. In this region, the "Westers/Pratt" models have evolved into Alaskan models through a series of small refinements. These models are now being used for planning and rearing fish. Recently, information from other workers (e.g., Klontz[1], pers. comm. and Piper et al. 1982) has been incorporated into our models. Use of these models is increasing, particularly because of the increased use of computers. The models must be further field tested and refined to optimize operation of the facilities.

Project Status:

The need to develop a standardized hatchery management program to optimize use of computers located in hatcheries has been identified as a high priority. A meeting was held with Daryl Jennings[2] (U. S. Fish and Wildlife Service, Denver) to review his progress with a hatchery management program for the federal hatchery system. With this unfinished program as a model, the "Hatchery Management Program for Alaskan Hatcheries" was written in dBase-III by ADF&G, Fisheries Rehabilitation, Enhancement and

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[1] University of Idaho.

[2] U. S. Fish and Wildlife Service, Denver.

Development Division Research/Analyst Marianne McKean. The program is now in its first level of field testing. Much of the work done by Ms. McKean could not have been accomplished so rapidly had it not been for the cooperation and collaboration with Mr. Jennings and the U. S. Fish and Wildlife Service.

Female Age vs. Egg Quality

General Information:

During the 1986 rainbow trout production cycle, eggs taken from the Big Lake strain broodstock were of very poor quality, as compared to eggs taken from the same fish the previous year. It was suspected that differences in egg quality may have been associated with the age of the female parent. To determine how many years broodstock should be used, their contribution to the program must be evaluated yearly for maximal efficiency and cost-effectiveness.

Project Status:

Survival rates have been calculated and analyzed for BY 1987 and no significant differences in survival rates were observed between progeny from females of different age classes in 1987. Data from BY 1988 have been collected, but not yet analyzed; a report will be presented when the project is completed.

Rainbow Trout Egg Survival: a Male or Female Trait?

General Information:

During the 1986 rainbow trout production cycle, the survival rate of green eggs to the eyed stage was very poor. Survival rates among production lots varied from 22% to 65% and averaged 48%, while survival rates among select-lot families ranged from 3.4% to 98.9% and averaged 76.7%. If it could be determined at the

time of spawning which individuals caused poor survival of eggs, both egg survival and environmental conditions within the incubators could be improved if these fish were not used for egg takes.

Project Status:

Data have been collected and analyzed and a report will be completed for this unfunded project as soon as possible.

Rainbow Trout Egg Fertilization

General Information:

During the 1986 rainbow trout production cycle, most of the green-to-eyed egg mortality was caused by infertile eggs or eggs that did not develop a visible embryo. It was suspected that the method used to add milt to the green eggs may have caused the low fertility rate.

According to this method, eggs are taken in a net and placed in a bucket. After eggs from a fixed number of females are combined in the bucket, milt from several males is added, one male at a time. This process may take from 2 to 10 min. After all the milt is added, the eggs and milt are gently mixed by hand and water is added to activate the sperm. If sperm motility lasts for less than a minute, however, sperm from only the first few males may be fertilizing only the eggs they contact before mixing occurs. This study was designed to determine if sperm is activated by the small amount of ovarian fluid present.

Project Status:

This project has been completed. The Project Completion Report is titled Section B (Volume 3, Number 5B) of this series. The final report will also be submitted to "The Progessive Fish-

Culturist" for publication and for presentation at the annual meeting of the Alaska Chapter of the American Fisheries Society in November 1988.

Rainbow Trout Diet Comparison (Production)

General Information:

The 1986 production year was unsuccessful because of high mortality of rainbow trout fingerlings that were reared at Fort Richardson Hatchery. The livers of the involved fish appeared abnormal. Charlie Smith[3] (pers. comm.) suggested that the liver condition probably resulted from improper nutrition. He had observed similar conditions among progeny of wild fish reared in a hatchery. He suggested that a liver additive be used in the feed and offered his nutrition lab for assistance. Four feeds were selected for testing: (1) OMP, (2) Alaska Dry Pellet, (3) Biodiet, (4) and Biodiet with liver.

Project Status:

This project has been completed and the final report is titled Section C (Volume 3, Number 5C) of this series. The final report will also be submitted to "The Progessive Fish-Culturist" for publication and for presentation at the annual meeting of the Alaska Chapter of the American Fisheries Society in November 1988.

Rainbow Trout Diet Comparison (Broodstock)

General Information:

The rainbow trout production program at Fort Richardson Hatchery experienced a major setback during the 1986 production cycle. It

[3] U. S. Fish and Wildlife Service, Bozeman Fish Technology Center.

appeared that poor nutrition was a contributing factor. The implication was great enough that it was decided to replace OMP with another feed for all production fish during the 1987 production cycle until they reached an average size of 2.0 g. It was also assumed that if the production fish were improperly nourished, the broodstock would also be affected and poor quality eggs would be produced. If, however, the quality of the broodstock and progeny could be improved through better nutrition, program efficiency would also be improved by reducing the number of fish held, feed costs, and labor.

Project Status:

This project was delayed one year because of the high post-spawning mortality during 1987. The project is now being conducted with a comparison of OMP and Moore Clark's* brood diet. No information will be available until survival rates and development of progeny can be compared during BY 1989.

Rainbow Trout Broodstock Questionnaire

General Information:

Because of the geographic distances between the BDC and other rainbow trout broodstock facilities in the United States and Canada, it has been difficult to observe hatchery techniques used by other facilities. To assemble, summarize, and share this knowledge, a "Broodstock Questionnaire" about hatchery broodstock management was distributed.

Project Status:

This project is complete. The Project Completion Report is titled Section D (Volume 3, Number 5D) of this series. The final report will also be submitted to the "Progessive Fish-Culturist" for publication. It was presented at both the National Cold

Water Broodstock Meeting in Colorado in September 1987 and at the annual meeting of the Alaska Chapter of the American Fisheries Society in November 1987.

Production of All-Female Rainbow Trout

General Information:

A major problem associated with the production stocking and harvesting of Alaskan rainbow trout is the high mortality that occurs when 2-year-old males mature. This loss, in addition to the detrimental effects of sexual maturation on growth, survival, and flesh quality, results in an overall loss of yield. Consequently, production of an "all-female" fish population and, eventually, sterile (triploid) female fish may reduce this loss in yield.

The objectives of this project are: (1) to adapt developed techniques to produce all-female rainbow trout; (2) to produce an all-female rainbow trout population at the BDC; and (3) to evaluate the hatchery and field performance of the all-female stock.

Project Status:

This project began during the egg take in April 1988. Fry are presently being fed 17-alpha-methyltestosterone to produce functional males.

Approximately half of these fish should be genotypically male (XY) and half genotypically female (XX). The sex of individuals will be determined by surgically removing the immature gonads for microscopic examination under the microscope. This project is unfunded, so labor required will be borrowed from other projects. This project will be continued when possible.

Experimental Production of Triploid Rainbow Trout

General Information:

The ADF&G, Sport Fish Division has requested that sterile rainbow trout be produced for the Anchorage area lake-stocking program. Two-year-old male rainbow trout suffer high mortality (e.g., greater than 50% in the hatchery) as they become sexually mature. Both male and female trout expend large quantities of energy to form sex products and their behavior during the process of sexual maturation generally makes the fish unavailable to anglers. Sterile fish would have lower natural mortality and increased average size associated with a longer life expectancy and the expenditure of energy for growth rather than sex products. Consequently, either the current level of sport fishing success (catch-per-unit of effort) can be maintained with fewer fish stocked, or the number of fish stocked may be increased. This technology may also have a useful application for anadromous stocks.

Project Status:

This project was started during the BY-1988 egg takes. Eggs were exposed to heat shock at water temperatures of 27°C and 29°C. Test lots were placed in the heated water bath at 5 and 10 min. Replications of each treatment were made. Progeny are being reared until triploidy determinations can be made in September 1988. A final report for this project will be completed when funds are available, or as time allows.

FACILITY DEVELOPMENT

Two tables that contain a total of 18 rearing tanks for the triploid rainbow trout production project were constructed and

installed in the wet laboratory. The rearing tanks are surplus Edo® incubators that have been modified to rear fish. The head box supplying these rearing tanks with water was also fitted with an oxygen/water contactor to reduce nitrogen gas in the water to below saturation.

SUMMARY

The objective of the BDC is to maintain and develop broodstock for rainbow trout enhancement programs in southcentral and interior Alaska. Presently, Swanson River and Big Lake strain broodstocks are being held in the BDC. A total of 6.1 million eggs was taken from these fish in the spring of 1988. The egg take went smoothly and egg survival was good.

This is the third year of the genetic-selection program. The 1986 and 1987 select lots are now being reared in outside raceways. The 1988 select-lot egg take went very smoothly and the fry are being reared in indoor raceways until final selection occurs.

Concurrent with the spring egg take, two projects were initiated: (1) Production of All-Female Broodstock, and (2) Production of Triploid Rainbow Trout. Data were also collected for the "Female Age vs. Egg Quality" project. This data will be analyzed and reports submitted next fiscal year. The "Alaska Hatchery Management Program" was developed and is now being field tested. The "Rainbow Trout Diet Comparison (Broodstock)" project was also begun at the end of this fiscal year.

Final reports of the "Rainbow Trout Broodstock Questionnaire," "Rainbow Trout Egg Fertilization," and "Rainbow Trout Diet Comparison (Production)" projects are being submitted to "The

Progressive Fish-Culturist" for publication and for presentation at professional conferences.

ACKNOWLEDGMENTS

I would like to thank Bill Hauser and J. S. Holland for their technical review of this paper and editorial assistance.

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